What's In Your Watershed?

Salt and Water Quality in the Southern Cayuga Lake Watershed

Tompkins County Cooperative Extension, Ithaca, NY

December 7, 2016

Community Science Institute and Cayuga Lake Watershed Network


Volunteer Stream Monitoring Reveals Rising Salt Levels in Ground Water
Stephen Penningroth, Executive Director
Community Science institute

Community Science Institute

Nonprofit 501(c)3 tax-exempt environmental organization founded in 2000

Mission: Partner with community-based volunteer groups to better understand and protect local streams and lakes by collecting and disseminating scientifically credible, regulatory-quality data that inform long-term, sustainable management strategies

Staff: Four (4) full-time, five (5) part-time

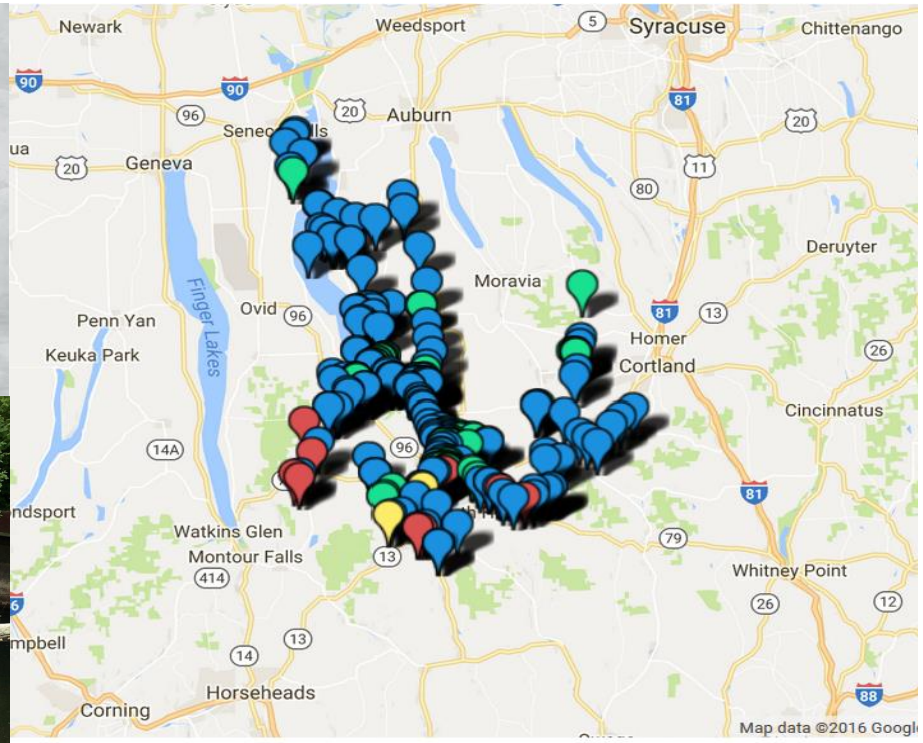
Budget: $226,000 in 2015

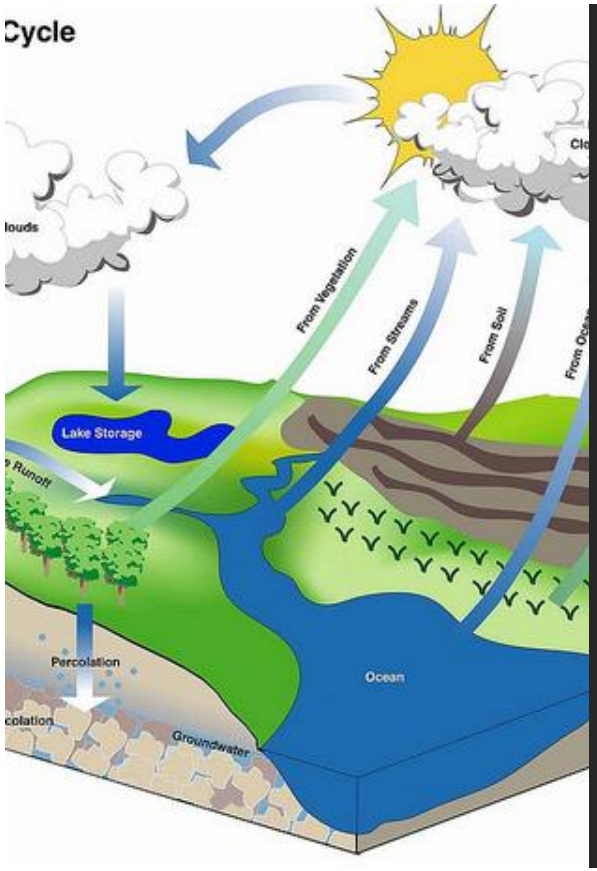
Partnerships between volunteer groups and certified environmental testing lab: Our lab has been certified by NY State and EPA since 2003 for chemistry and microbiology, including phosphorus and nitrogen nutrients, E. coli, sediment, chloride and several other indicators; also certified for drinking water

Stream biomonitoring partnerships with volunteer groups: Two (2) staff are certified BMI taxonomists who support volunteers' collection and analysis of BMI organisms as indicators of general ecosystem health

Public online data archive at database@communityscience.org: Public can view maps and graphs, search over 90,000 results and download search results free of charge

Volunteer-CSI monitoring partnerships investigate salt (NaCl) at over 100 stream locations in the Cayuga Lake watershed using chloride (Cl) as a marker



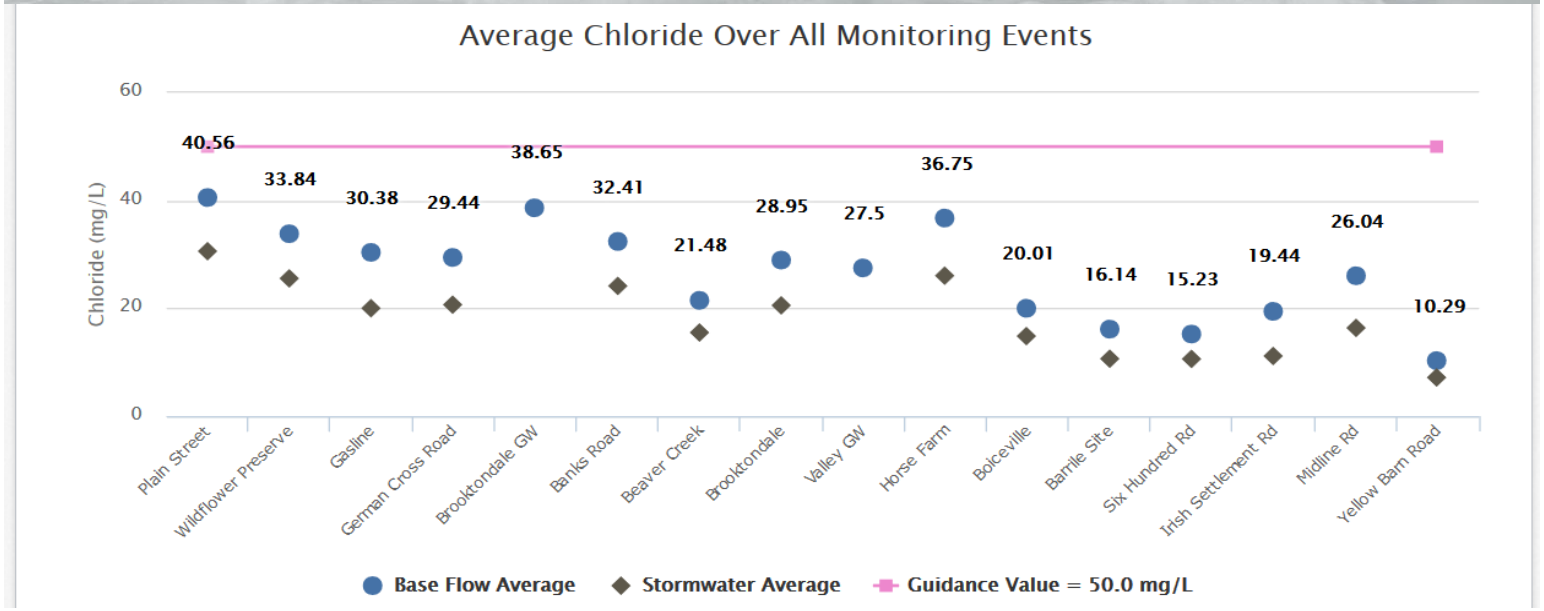


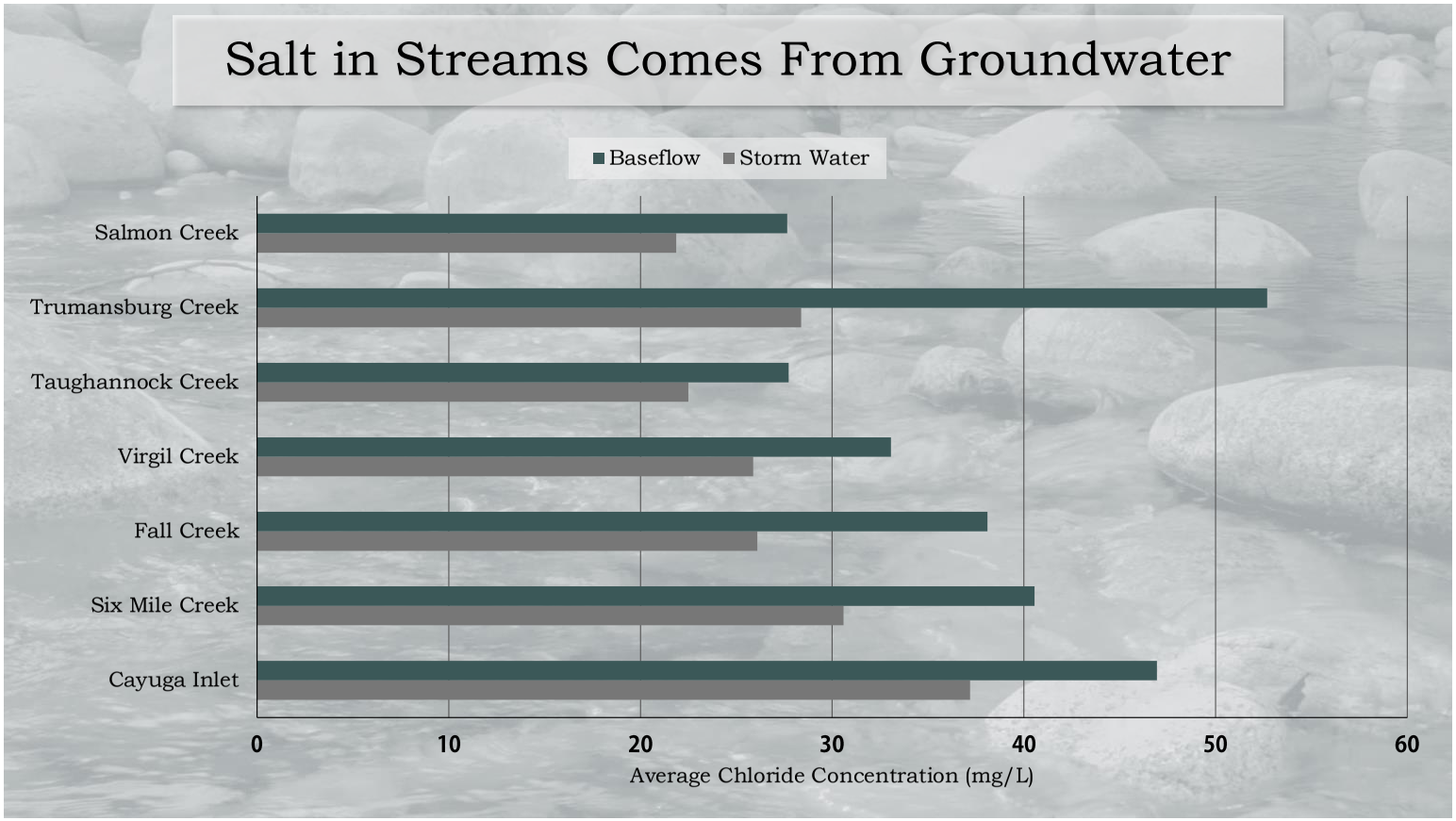
How to tell if a chemical in a stream comes from groundwater

- In the global hydrologic cycle, water in the atmosphere falls to the ground, recharging groundwater supplies
- Flowing downgradient due to gravity, groundwater enters surface water bodies such as streams and lakes
- At base flow, most of the water in streams comes from groundwater; the chemical composition is the result of, a) Interactions between groundwater and the minerals in its path, and b) Chemicals entering from the surface
- Following a heavy rain or snow melt, the concentrations of groundwater constituents in streams decrease due to dilution by the relatively pure rain water or snow melt running off the surface, i.e., by stormwater runoff

Long-term data sets indicate:

1) Salt enters streams through groundwater, and
2) In most streams, salt increases from headwaters to mouth




Salt in Streams Comes From Groundwater
Baseflow
Storm Water
Salmon Creek
Trumansburg Creek
Taughannock Creek
Virgil Creek
Fall Creek
Six Mile Creek
Cayuga Inlet
0
10
20
30
40
50
60
Average Chloride Concentration (mg/L)

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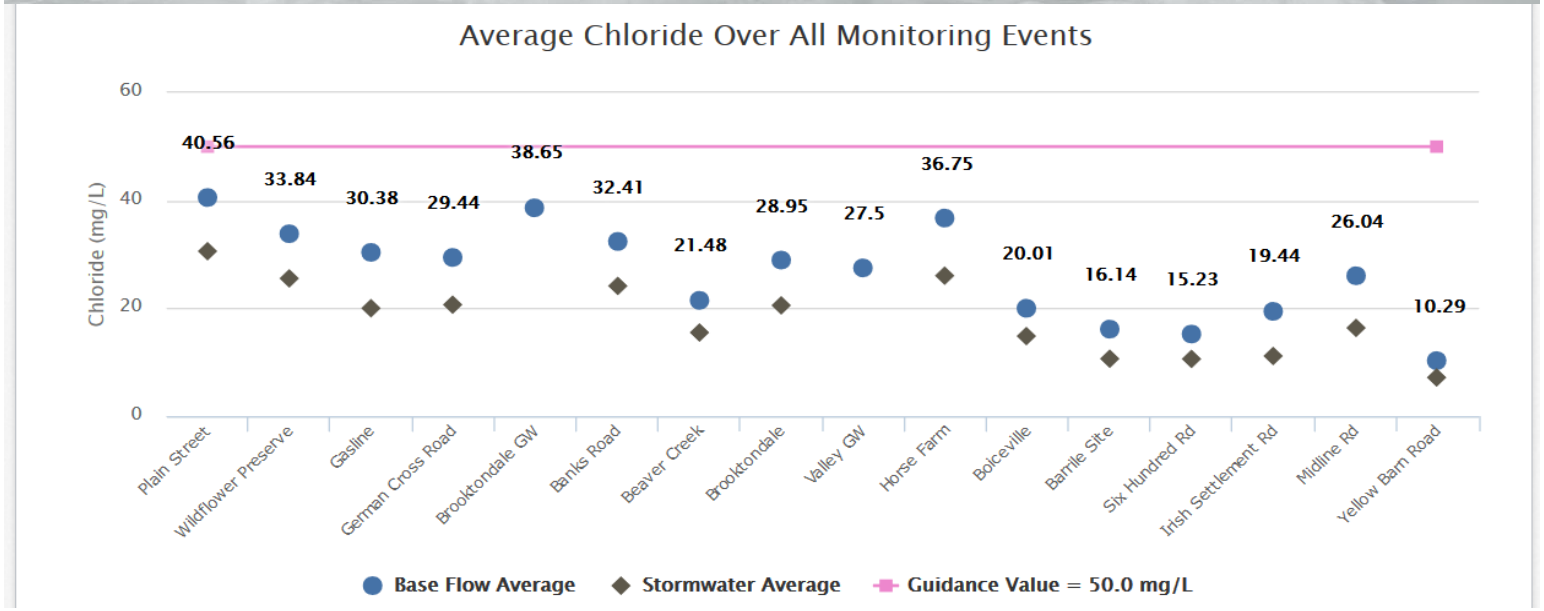
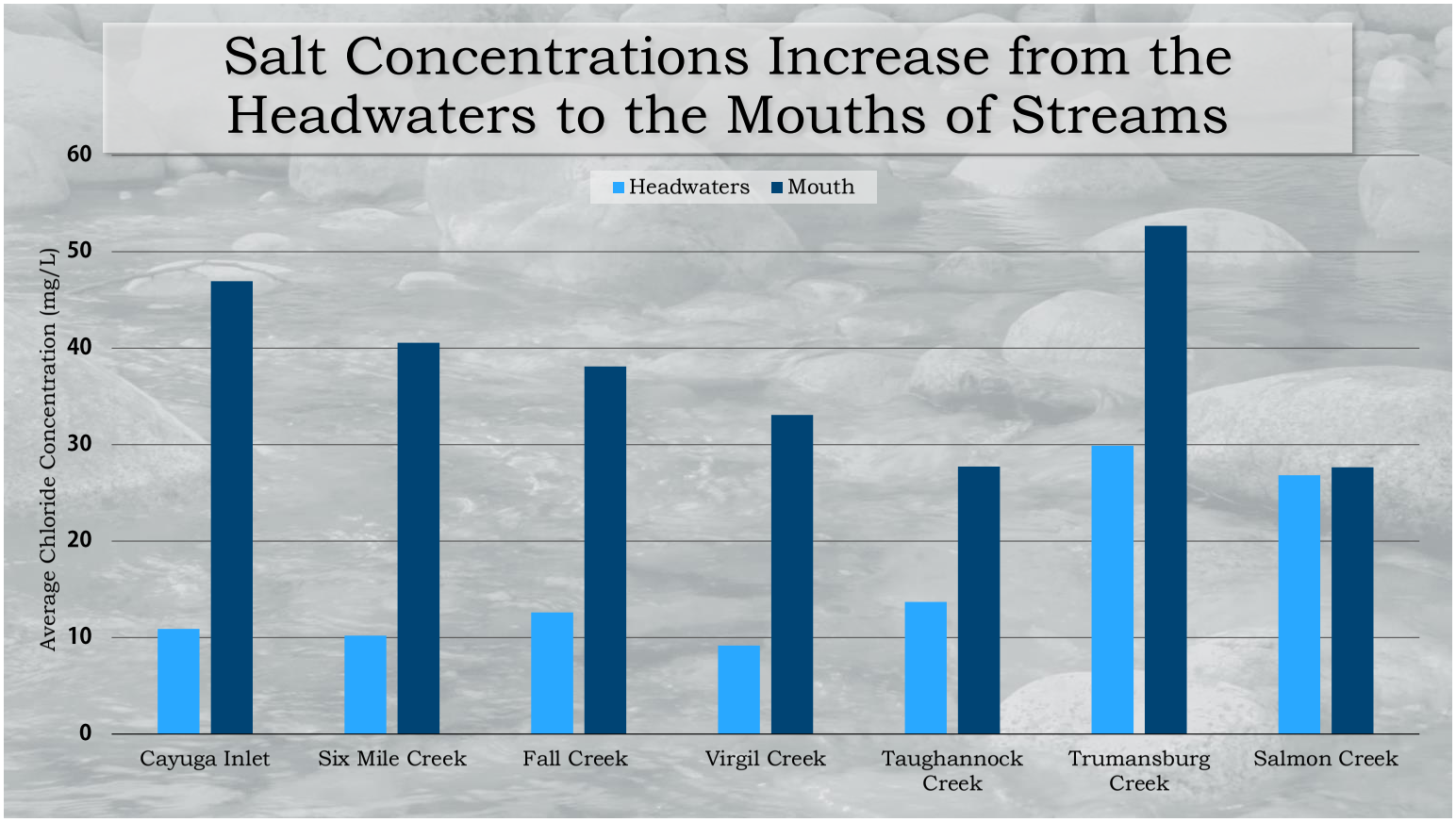
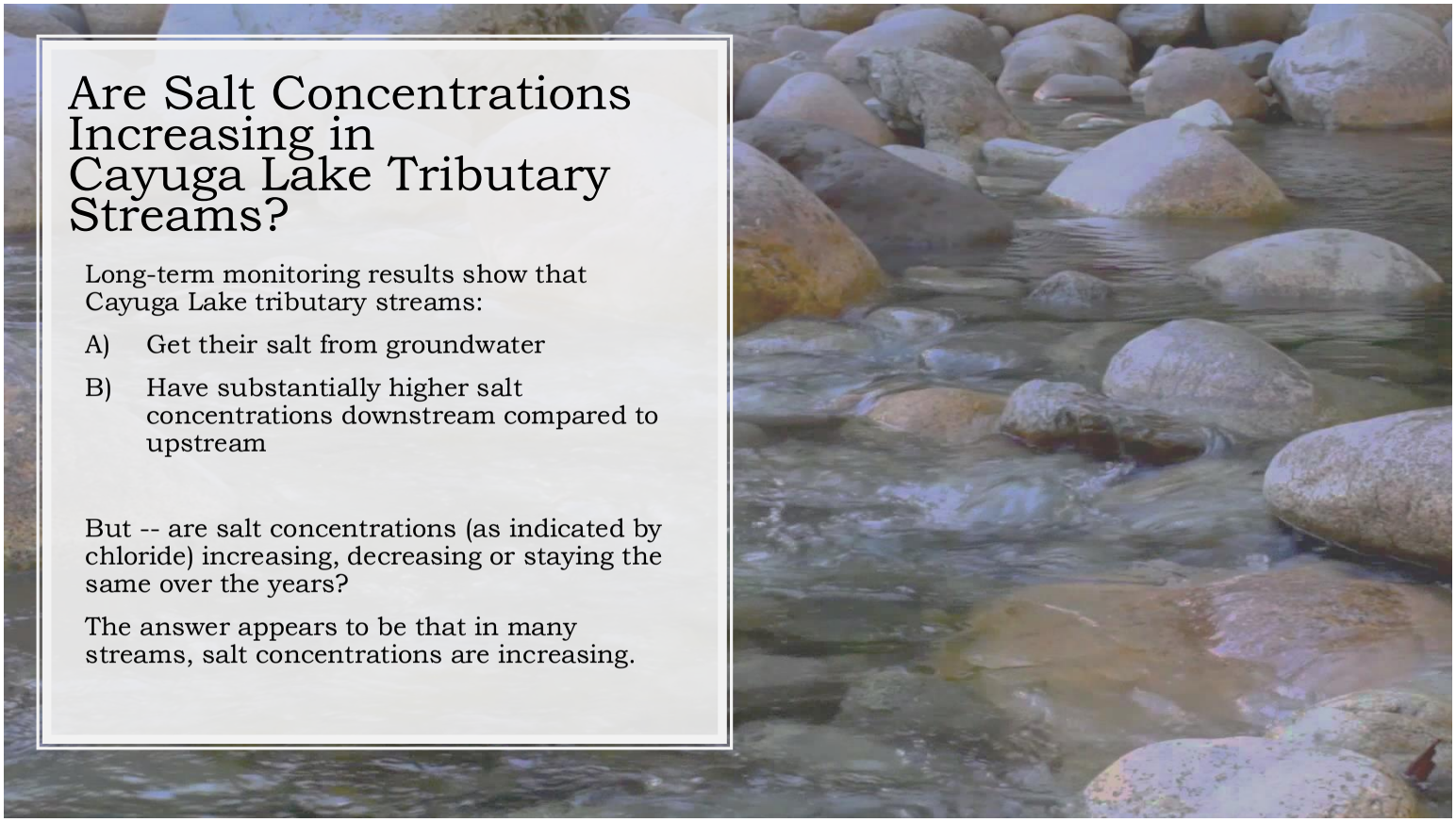



Salt Concentrations Increase from the Headwaters to the Mouths of Streams
Headwaters
Mouth
Average Chloride Concentration (mg/L)
60
50
40
30
20
10
0
Cayuga Inlet
Six Mile Creek
Fall Creek
Virgil Creek
Taughannock Creek
Trumansburg Creek
Salmon Creek



Are Salt Concentrations Increasing in Cayuga Lake Tributary Streams?

Long-term monitoring results show that Cayuga Lake tributary streams:

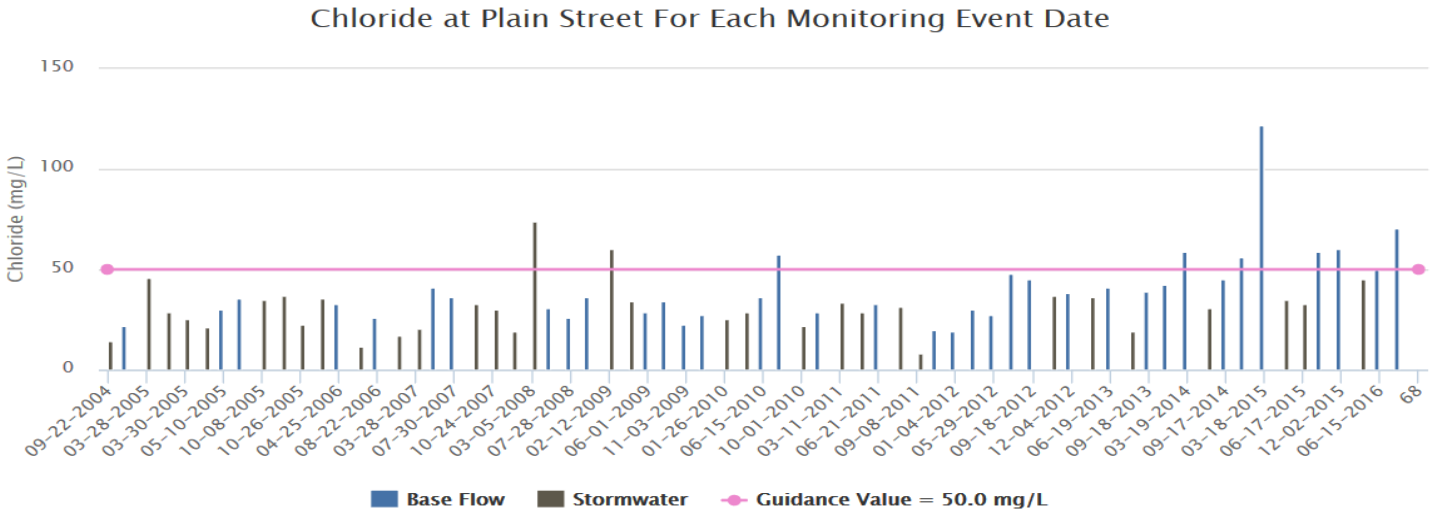
A) Get their salt from groundwater

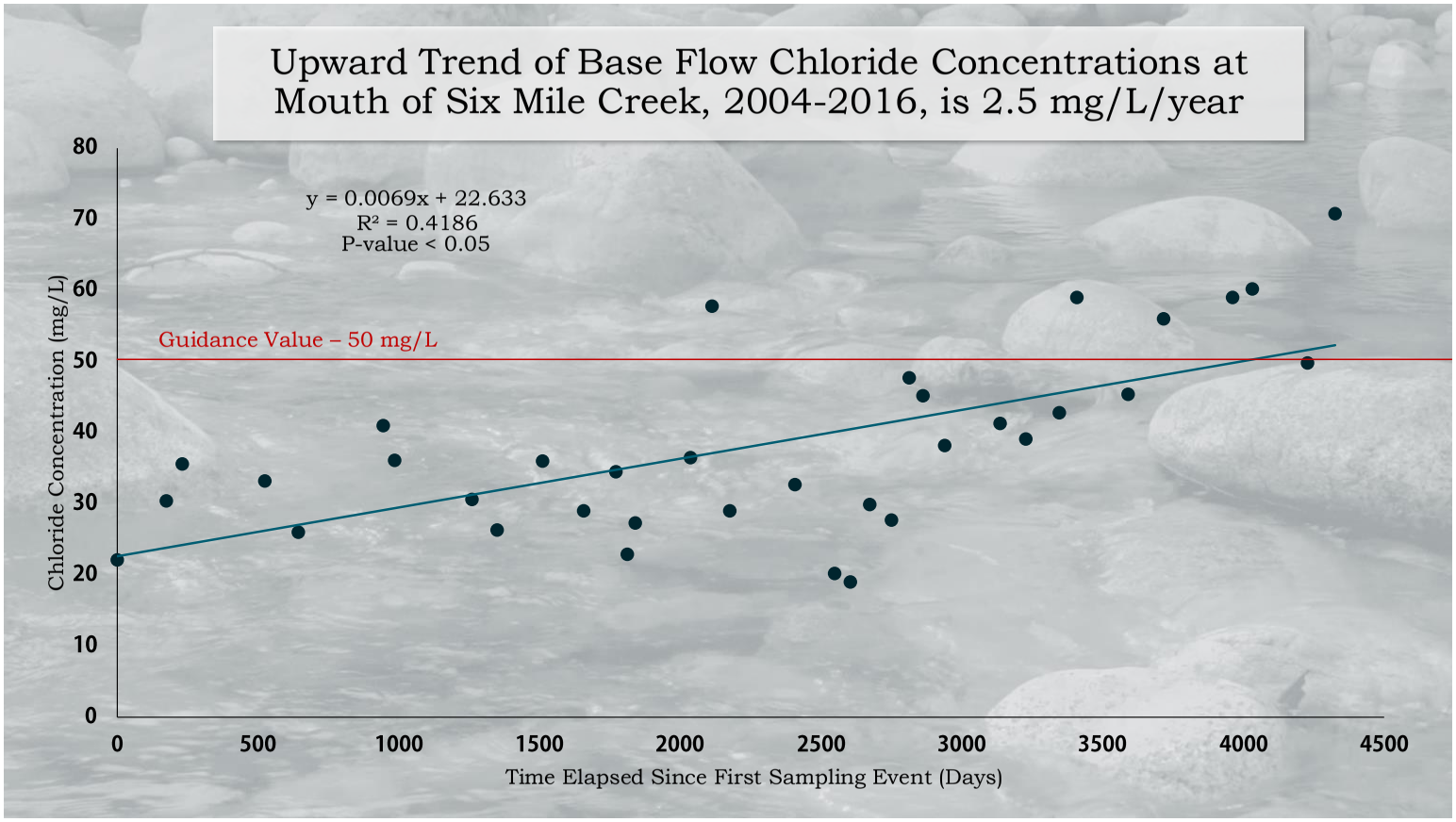
B) Have substantially higher salt concentrations downstream compared to upstream

But -- are salt concentrations (as indicated by chloride) increasing, decreasing or staying the same over the years?

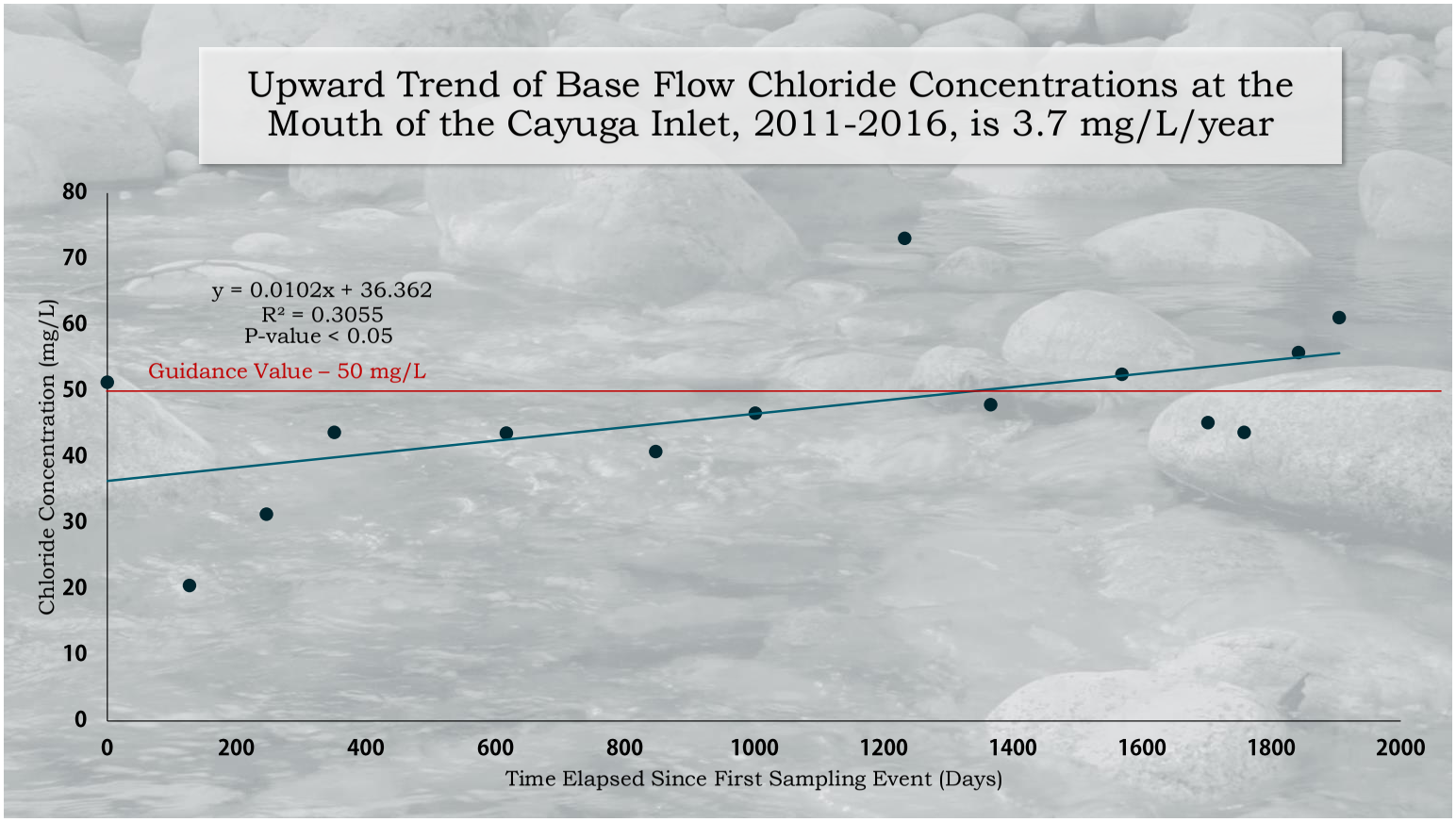
The answer appears to be that in many streams, salt concentrations are increasing.

Visual inspection of chloride concentrations at stream mouths over a period of years, as displayed in CSI's public online database, provides a point of departure for analysis of rising salt levels in streams and, by direct inference, in groundwater.

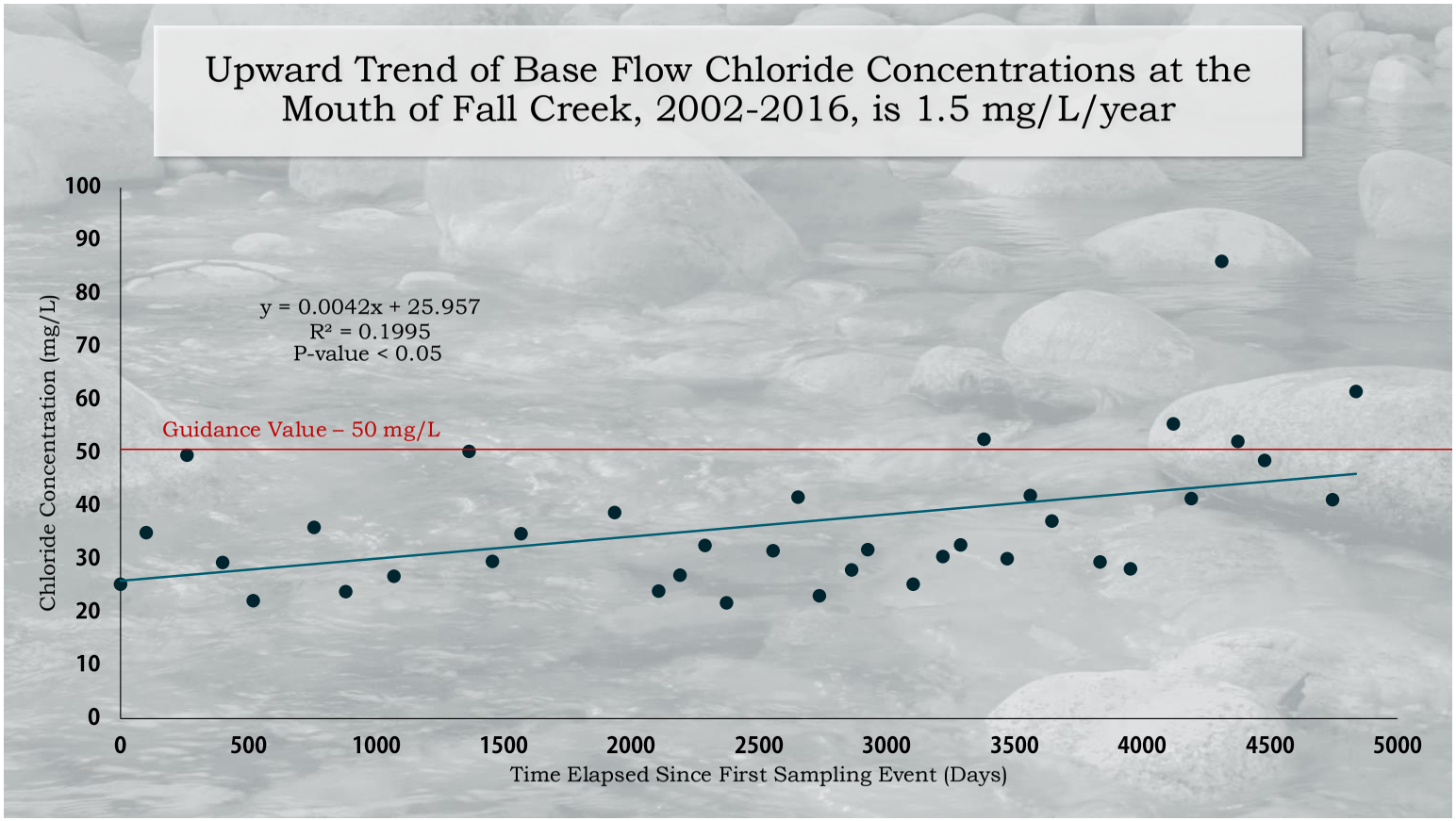


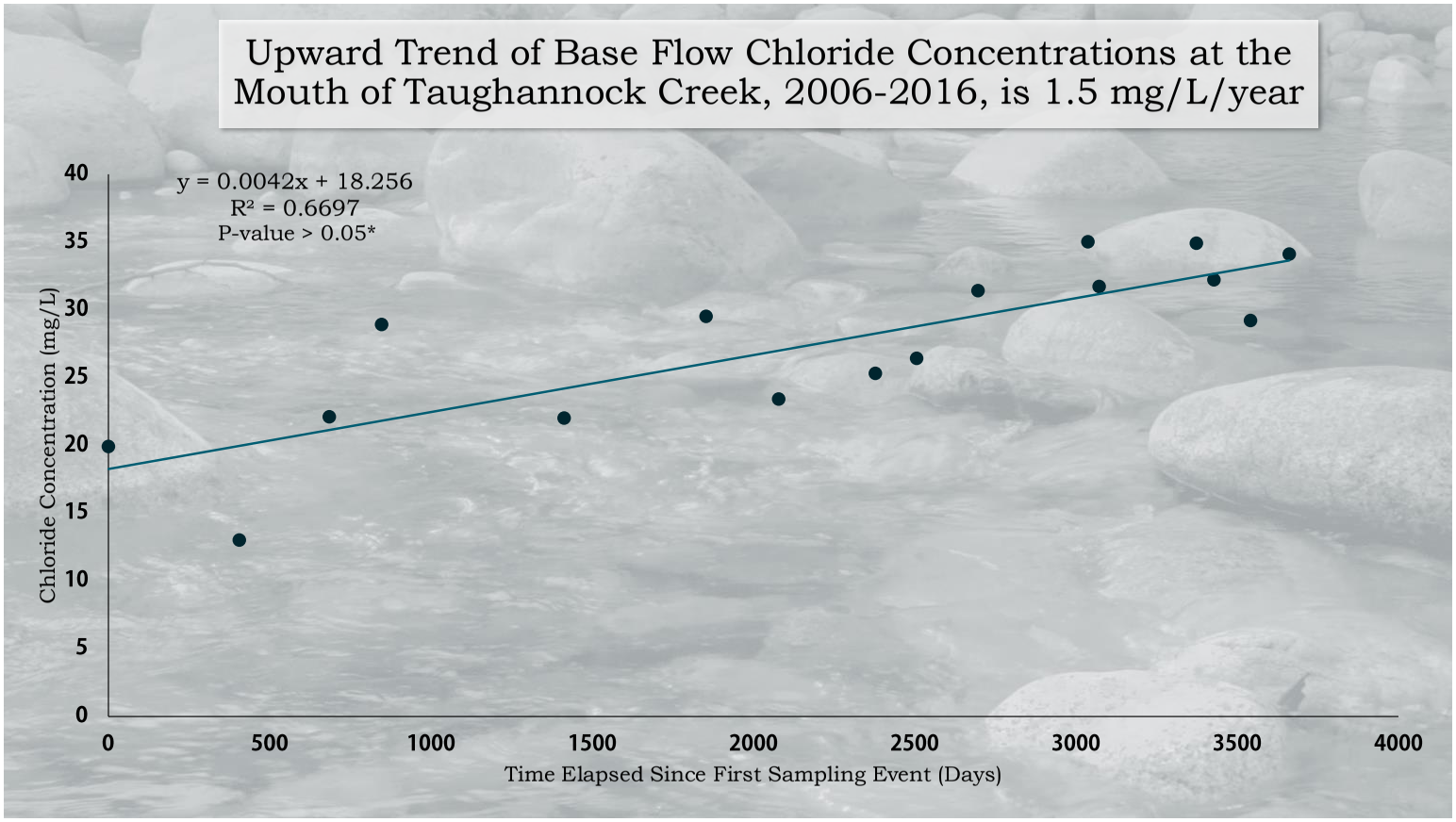

Upward Trend of Base Flow Chloride Concentrations at Mouth of Six Mile Creek, 2004-2016, is 2.5 mg/L/year
y = 0.0069x + 22.633
R² = 0.4186
P-value < 0.05
Guidance Value – 50 mg/L
Chloride Concentration (mg/L)
0
10
20
30
40
50
60
70
80
0
500
1000
1500
2000
2500
3000
3500
4000
4500
Time Elapsed Since First Sampling Event (Days)

Upward Trend of Base Flow Chloride Concentrations at the Mouth of the Cayuga Inlet, 2011-2016, is 3.7 mg/L/year

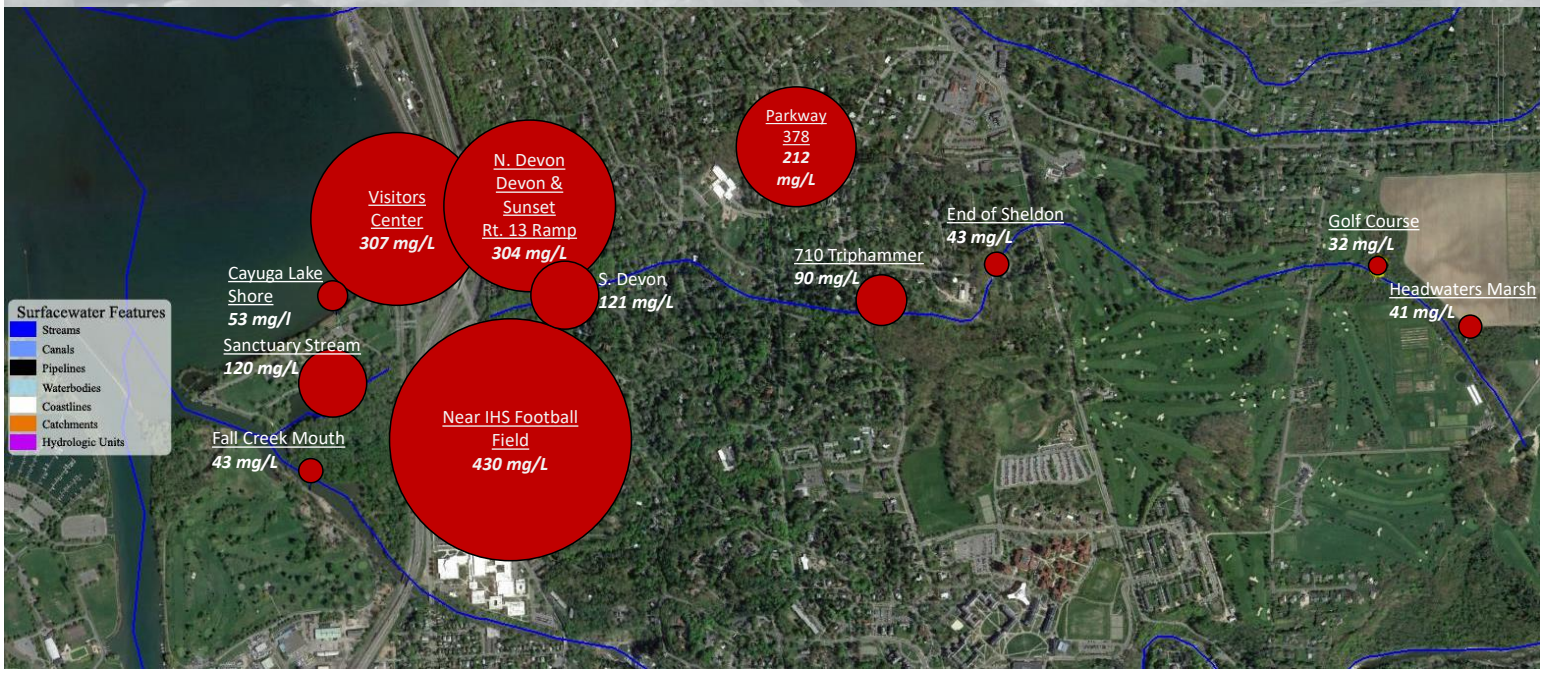


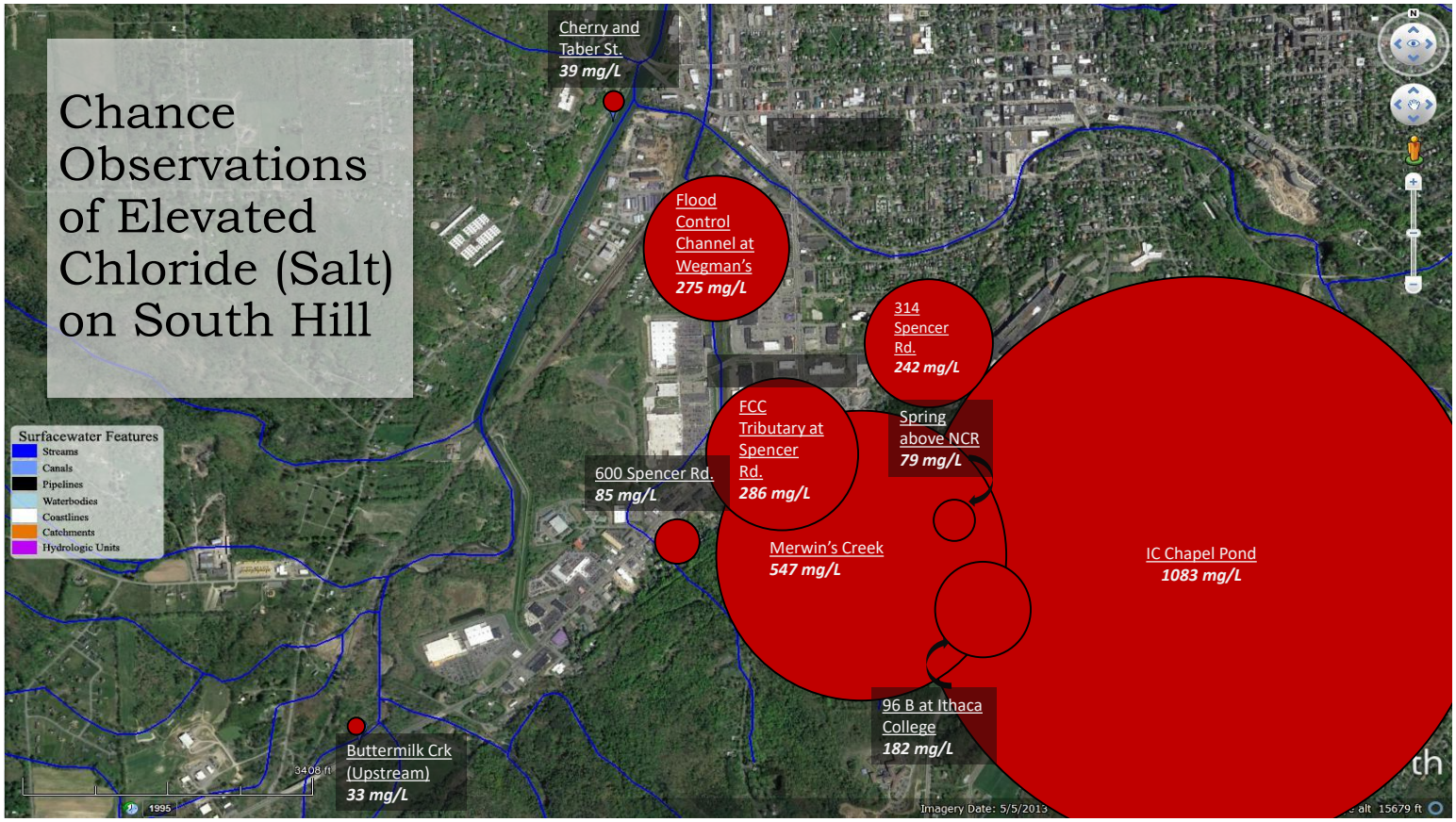
Upward Trend of Base Flow Chloride Concentrations at the Mouth of Fall Creek, 2002-2016, is 1.5 mg/L/year




Upward Trend of Base Flow Chloride Concentrations at the Mouth of Taughannock Creek, 2006-2016, is 1.5 mg/L/year
y = 0.0042x + 18.256
R² = 0.6697
P-value > 0.05*
Chloride Concentration (mg/L)
0
5
10
15
20
25
30
35
40
0
500
1000
1500
2000
2500
3000
3500
4000
Time Elapsed Since First Sampling Event (Days)

Chance Observations of Elevated Chloride (Salt) on East Hill




Chance Observations of Elevated Chloride (Salt) on South Hill
Cherry and Taber St.
39 mg/L
Flood Control Channel at Wegman's
275 mg/L
314 Spencer Rd.
242 mg/L
FCC Tributary at Spencer Rd.
286 mg/L
Spring above NCR
79 mg/L
600 Spencer Rd.
85 mg/L
Merwin's Creek
547 mg/L
IC Chapel Pond
1083 mg/L
96 B at Ithaca College
182 mg/L
Buttermilk Crk (Upstream)
33 mg/L
Surfacewater Features
Streams
Canals
Pipelines
Waterbodies
Coastlines
Catchments
Hydrologic Units
3408 ft
1995
Imagery Date: 5/5/2013

Conclusions

1. Salt is rising in groundwater throughout the southern Cayuga Lake watershed.
2. Salt concentrations in groundwater are rising at annual rates of about 1.5 to 3.7 mg/L/year.
3. Salt concentrations are 2x – 4x higher near the mouths of streams than near their headwaters, indicating that the rise in groundwater salt correlates with road density increases and land use changes from rural to urban/commercial.
4. The surface waters around Ithaca are littered with surprising pockets of high salt concentrations; high salt on South Hill might contribute to the faster rise and higher levels of salt in the Cayuga Inlet compared to other streams.
5. Possible sources contributing to rising salt levels include road salt, water softeners and geology.

Acknowledgements

CSI's volunteer monitoring partner groups –These data would not exist without them

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